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1. GENERAL BACKGROUND INFORMATION

ACRONYMS AND ABBREVIATIONS USED IN THIS BULLETIN

ACTS	- Automated Computer Time Service
BIPM	- Bureau International des Poids et Mesures
CS	- Cesium Standard
GPS	- Global Positioning System
IERS	- International Earth Rotation Service
LORAN	- Long Range Navigation
MC	- Master Clock
MJD	- Modified Julian Date
NIST	- National Institute of Standards and Technology
NOAA	- National Oceanic and Atmospheric Administration
NVLAP	- National Voluntary Laboratory Accreditation Program
SI	- International System of Units
TA	- Atomic Time
TAI	- International Atomic Time
USNO	- United States Naval Observatory
UTC	- Coordinated Universal Time

ns	- nanosecond
µs	- microsecond
ms	- millisecond
s	- second
min	- minute

2. TIME SCALE INFORMATION

The values listed below are based on data from the IERS, the USNO, and NIST. The UTC(USNO,MC) - UTC(NIST) values are averaged measurements from all available common-view GPS satellites (see bibliography on page 5). UTC - UTC(NIST) data are on page 3.

0000 HOURS COORDINATED UNIVERSAL TIME			
Jan 2010	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC) - UTC(NIST) (±20 ns)
7	55203	107 ms	9 ns
14	55210	104 ms	8 ns
21	55217	098 ms	7 ns
28	55224	093 ms	5 ns

The master clock pulses used by the WWV, WWVH, and WWVB time-code transmissions are referenced to the UTC(NIST) time scale. Occasionally, 1 s is added to the UTC time scale. This second is called a leap second. Its purpose is to keep the UTC time scale within ±0.9 s of the UT1 astronomical time scale, which changes slightly due to variations in the Earth's period of rotation.

NOTE: No leap second was added at the end of December 2009.

Positive leap seconds, beginning at 23 h 59 min 60 s UTC and ending at 0 h 0 min 0 s UTC, were inserted in the UTC time scale on 30 June 1972, 1981-1983, 1985, 1992-1994, and 1997, and on 31 December 1972-1979, 1987, 1989, 1990,1995, 1998, 2005, and 2008.

The use of leap seconds ensures that UT1 - UTC will always be held within ±0.9 s. The current value of UT1 - UTC is called the DUT1 correction. DUT1 corrections are broadcast by WWV, WWVH, WWVB, and ACTS and are printed below. These corrections may be added to received UTC time signals in order to obtain UT1.

DUT1 = UT1 - UTC =	+0.1 s beginning 0000 UTC 12 November 2009
	+0.2 s beginning 0000 UTC 11 June 2009
	+0.3 s beginning 0000 UTC 12 March 2009
	-0.6 s beginning 0000 UTC 20 November 2008
	-0.5 s beginning 0000 UTC 07 August 2008

The difference between UTC(NIST) and UTC has been within ±100 ns since July 6, 1994. The table below shows values of UTC - UTC(NIST) as supplied by the BIPM in their *Circular T* publication for the most recent 310-day period in which data are available. Data are given at 10-day intervals. Five-day interval data are available in *Circular T*.

0000 Hours Coordinated Universal Time		
DATE	MJD	UTC-UTC(NIST) ns
Dec. 24, 2009	55189	16.0
Dec. 14, 2009	55179	17.9
Dec. 04, 2009	55169	18.1
Nov. 24, 2009	55159	15.6
Nov. 14, 2009	55149	14.1
Nov. 04, 2009	55139	7.8
Oct. 25, 2009	55129	3.9
Oct. 15, 2009	55119	0.6
Oct. 05, 2009	55109	-5.2
Sep. 25, 2009	55099	-10.2
Sep. 15, 2009	55089	-13.8
Sep. 05, 2009	55079	-15.1
Aug. 26, 2009	55069	-15.8
Aug. 16, 2009	55059	-16.4
Aug. 06, 2009	55049	-14.7
Jul. 27, 2009	55039	-12.3
Jul. 17, 2009	55029	-9.6
Jul. 07, 2009	55019	-4.9
Jun. 27, 2009	55009	0
Jun. 17, 2009	54999	4.7
Jun. 07, 2009	54989	5.7
May 28, 2009	54979	10.3
May 18, 2009	54969	11.2
May 08, 2009	54959	10.8
Apr. 28, 2009	54949	9.7
Apr. 18, 2009	54939	7.0
Apr. 08, 2009	54929	10.0

3. PHASE DEVIATIONS FOR WWVB AND LORAN-C

WWVB - The values shown for WWVB are the time differences between the time markers of the UTC(NIST) time scale and the first positive-going zero voltage crossover measured at the transmitting antenna. The uncertainty of the individual measurements is ±0.5 μs. The values listed are for 1300 UTC.

LORAN-C - The values shown for LORAN-C represent the daily accumulated phase shift. The phase shift is measured by comparing the output of a LORAN receiver to the UTC(NIST) time scale for a period of 24 h. If data were not recorded on a particular day, the symbol (-) is printed. The stations monitored are Baudette, Minnesota (8970) and Boise City, Oklahoma (9610). The monitoring is done from the NIST laboratories in Boulder, Colorado.

Note: The values shown for LORAN-C are in nanoseconds.

		UTC(NIST)-WWVB (60 kHz)	UTC(NIST) - LORAN PHASE (ns)	
DATE	MJD	ANTENNA PHASE (μs)	LORAN-C (BAUDETTE) (8970)	LORAN-C (BOISE CITY) (9610)
01/01/2010	55197	5.65	+12	-10
01/02/2010	55198	5.65	-49	+2
01/03/2010	55199	5.65	-58	-38
01/04/2010	55200	5.65	+28	+4
01/05/2010	55201	5.65	+14	-31
01/06/2010	55202	5.65	+60	+55
01/07/2010	55203	5.65	-28	+18
01/08/2010	55204	5.65	-11	-8
01/09/2010	55205	5.65	+20	-59
01/10/2010	55206	5.65	-42	-17
01/11/2010	55207	5.65	+60	+10
01/12/2010	55208	5.65	-102	-5
01/13/2010	55209	5.65	-44	-21
01/14/2010	55210	5.65	+112	0
01/15/2010	55211	5.65	+6	-1
01/16/2010	55212	5.65	-108	+13
01/17/2010	55213	5.65	+2	-1
01/18/2010	55214	5.65	+30	-9
01/19/2010	55215	5.65	+44	+5
01/20/2010	55216	5.65	+22	+15
01/21/2010	55217	5.65	+81	-5
01/22/2010	55218	5.65	-97	-7
01/23/2010	55219	5.65	-60	+15
01/24/2010	55220	5.65	-84	+9
01/25/2010	55221	5.65	+106	-26
01/26/2010	55222	5.65	-2	+1
01/27/2010	55223	5.65	+14	+12
01/28/2010	55224	5.65	+47	+26
01/29/2010	55225	5.65	+6	-15
01/30/2010	55226	5.65	+2	+5
01/31/2010	55227	5.65	+57	-14

4. BROADCAST OUTAGES OVER FIVE MINUTES AND WWVB PHASE PERTURBATIONS

OUTAGES OF 5 MINUTES OR MORE						PHASE PERTURBATIONS 2 ms			
Station	Jan 2010	MJD	Began UTC	Ended UTC	Freq.	Jan 2010	MJD	Began UTC	End UTC
WWVB	01-24-10	55220	1552	1652	60 kHz				
WWVB	01-24-10	55220	1325	1452	60 kHz				
WWV									
WWVH									

5. NOTES ON NIST TIME SCALES AND PRIMARY STANDARDS

Primary frequency standards developed and operated by NIST are used to provide accuracy (rate) input to the BIPM. NIST-F1, a cold-atom cesium fountain frequency standard, has served as the U.S. primary time and frequency standard since 1999. The uncertainty of NIST-F1 is currently about 3 parts in 10^{16}.

The AT1 scale is run in real-time by use of data from an ensemble of cesium standards and hydrogen masers. It is a free-running scale whose frequency is maintained as nearly constant as possible by choosing the optimum weight for each clock that contributes to the computation.

UTC(NIST) is generated as an offset from our real-time scale AT1. It is steered in frequency towards UTC by use of data published by the BIPM in its *Circular T*. Changes in the steering frequency will be made, if necessary, at 0000 UTC on the first day of the month, and occasionally at mid-month. A change in frequency is limited to no more than ±2 ns/day. The frequency of UTC(NIST) is kept as stable as possible at other times.

UTC is generated at the BIPM by use of a post-processed time-scale algorithm and is not available in real-time. The parameters that we use to generate UTC(NIST) in real-time are therefore based on an extrapolation of UTC from the most recent available data.

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Table 7.1 lists parameters that are used to define UTC(NIST) with respect to our real-time scale AT1. To find the value of UTC(NIST) - AT1 at any time T (expressed as a Modified Julian Day, including a fraction if needed), the appropriate equation to use is the one for which the desired T is greater than or equal to the entry in the T_0 column and less than the entry in the last column. The values of x_{ls}, x, and y for that month are then used in the equation below to find the desired value. The parameters x and y represent the offsets in time and frequency, respectively, between UTC(NIST) and AT1; the parameter x_{ls} is the number of leap seconds applied to both UTC(NIST) and UTC, as specified by the IERS. Leap seconds are not applied to AT1.

Table 7.1
UTC(NIST) - AT1 = x_{ls} + x + y*(T –T_0)

Month	x_{ls} (s)	x (ns)	y (ns/d)	T_0 (MJD)	Valid until 0000 on: (MJD)
Mar 10	-34	-345688.3	-38.0*	55256	55287
Feb 10	-34	-344624.3	-38.0	55228	55256*
Jan 10	-34	-343446.3	-38.0	55197	55228
Dec. 09	-34	-342952.3	-38.0	55184	55197
Dec. 09	-34	-342261.1	-38.4	55166	55184†
Nov 09	-34	-341838.7	-38.4	55155	55166
Nov 09	-34	-341101.5	-38.8	55136	55155†
Oct 09	-34	-340441.9	-38.8	55119	55136
Oct 09	-34	-339895.9	-39.0	55105	55119†
Sep 09	-34	-339271.9	-39.0*	55089	55105
Sep 09	-34	-338730.1	-38.7	55075	55089†
Aug 09	-34	-337917.4	-38.7	55054	55075
Aug 09	-34	-337534.4	-38.3	55044	55054†
Jul 09	-34	-336691.8	-38.3	55022	55044
Jul 09	-34	-336349.8	-38.0	55013	55022†
Jun 09	-34	-335209.8	-38.0	54983	55013
May 09	-34	-334791.8	-38.0	54972	54983
May 09	-34	-334027.8	-38.2	54952	54972†
Apr 09	-34	-333225.6	-38.2	54931	54952
Apr 09	-34	-332880.9	-38.3	54922	54931†
Mar 09	-34	-331693.6	-38.3	54891	54922
Feb 09	-34	-330621.2	-38.3	54863	54891

† Rate change in mid-month
***Provisional value**